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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : C08L 25/06, 69/00, 33/12, 55/02, 25/12, 67/02, 67/00		A1	(11) International Publication Number: WO 99/50347
			(43) International Publication Date: 7 October 1999 (07.10.99)
(21) International Application Number: PCT/GB99/00946 (22) International Filing Date: 25 March 1999 (25.03.99) (30) Priority Data: 9806631.9 28 March 1998 (28.03.98) GB (71) Applicant (for all designated States except US): SAFEGLOSS (EUROPE) LIMITED [GB/GB]; James Watt Building, Scottish Enterprise Technology Park, East Kilbride G75 0QD (GB). (72) Inventor; and (75) Inventor/Applicant (for US only): McNEILL, Ralph [GB/GB]; James Watt Building, Scottish Enterprise Technology Park, East Kilbride G75 0QD (GB). (74) Agent: KENNEDY & CO.; Station House, 34 St. Enoch Square, Glasgow G1 4DF (GB).			(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(54) Title: SAFETY GLASS			
(57) Abstract Material for use as safety glass comprises a mixture of polymeric material and a thermoplastic polystyrene resin having a molecular weight of between 500 and 5000. The polymeric material is selected from high molecular weight impact or crystal polystyrene, polycarbonate, acrylic polymers, ABS, SAN and polyester. The material may further comprise ingredients selected from the list of UV inhibitors, antioxidants, flow modifiers, fire retarding agents, colour pigments and brighteners. The material is typically used in emergency equipment, glassware and windows.			

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1 SAFETY GLASS

2

3 The present invention relates to a type of safety glass,
4 particularly safety glass that can be used in storage
5 containers for emergency equipment.

6

7 At present there are several emergency devices where
8 glass is used. The glass is used for its transparency
9 and breakable properties, so that the person using the
10 emergency device, such as a fire-axe, can not only
11 observe the presence of the safety article in its
12 retaining box but can also easily break the glass to
13 access the device when required. Glass finds similar
14 applications in emergency door releases, fire alarm
15 activators and many other emergency devices.

16

17 The problem with the use of glass in such applications is
18 that the glass must be broken to access the device to be
19 used. Often there is a subsidiary device that can be
20 used to break the glass. However, this may be missing or
21 not be supplied as part of the device. In either case
22 the breakage of the glass will cause the previously
23 harmless sheet of glass to be broken into sharp glass
24 fragments and also glass splinters.

1

2 Needless to say the presence of sharp glass poses an
3 unnecessary hazard to the user, particularly if the sharp
4 glass injures the user in an attempt to access a safety
5 device.

6

7 The use of glass may often present other problems to the
8 potential user of a safety device, for example that
9 person may assume that the glass used is safety glass and
10 be surprised at any damage that they inflict upon
11 themselves and any others. The potential user may also
12 question as to whether they can access the device without
13 causing any damage to themselves, any such time wasted in
14 the case of an emergency could be crucial and should be
15 avoided.

16

17 It is also possible that malicious or accidental damage
18 may occur and the layer of glass in the retaining device
19 may be broken in a non-emergency situation. In any case
20 there may be sharp fragments of glass left behind, which
21 can be a danger to passers by.

22

23 Also some organisations now insist upon either a strict
24 control of glass usage within their buildings or the
25 complete prohibition of the use of glass. Some areas of
26 hospitals and food preparation are now insistent on being
27 glass free zones.

28

29 There has already been considerable research carried out
30 on products that can be used to replace glass. One such
31 product is perspex, which like glass is transparent and
32 being a polymeric material should not produce the same
33 shards as are produced by breaking glass.

34

1 However, the use of perspex and its related plastics is
2 not without its problems. Perspex can be harder to break
3 than glass as it is not as fragile and can still produce
4 sharp fragments that can injure the user in the same way
5 as glass can.

6

7 It is an object of the present invention to provide an
8 improved material for use as safety glass.

9

10 According to the present invention there is provided a
11 material having a tensile stress limit of between 11 and
12 60 Nmm^{-2} , that is or can be made transparent and can be
13 made into sheets/structures just like ordinary glass, but
14 that shatters when broken into fragments that are not
15 capable of damaging human skin or tissue and which is
16 comprised of a mixture of polymeric material and/or a
17 thermoplastic polystyrene resin and/or a thermoplastic
18 vinylaromatic resin.

19

20 Preferably the polymeric material is chosen from the
21 group consisting of crystal or impact polystyrene,
22 polycarbonate, acrylic, ABS (acrylonitrile butadiene
23 styrene), SAN (styrene and acrylic blend) and polyester.

24

25 Preferably the thermoplastic polystyrene resin is chosen
26 from the group consisting of co-polymers of styrene and
27 alpha methyl styrene, hydrogenated aliphatic polymer and
28 styrene monomer.

29

30 Preferably also the thermoplastic polystyrene resin has a
31 molecular mass of between 500 and 5000.

32

33 Preferably also the safety glass of the present invention
34 includes other ingredients selected from the list of UV

1 inhibitors, antioxidants, flow modifiers, fire retarding
2 agents, colour pigments and brighteners.

3

4 Preferably these ingredients are present in the safety
5 glass of the present invention at between 0.001% and
6 0.01%.

7

8 Preferably the safety glass of the present invention can
9 be etched upon.

10

11 In a preferred embodiment of the invention the safety
12 glass of the present invention is composed of crystal or
13 impact polystyrene (0-85%) and thermoplastic polystyrene
14 resin (0-15%) together with 0.001% to 0.01% UV
15 inhibitors, antioxidants, flow modifiers, fire retarding
16 agents, colour pigments and brighteners, which gives a
17 safety glass material which has a stress limit of between
18 11 and 60 Nmm⁻².

19

20 The preferred embodiment of the invention can be used in
21 such applications as emergency equipment enclosures (key
22 boxes, first aid boxes, fire extinguisher enclosures,
23 window hammer enclosures, access panels, door egresses
24 housing manually operated door handles), break glass fire
25 alarms and emergency kick out panels.

26

27 The preferred embodiment of the invention can also be
28 used in other applications such as drinking glasses,
29 bottles and non-emergency windows, preventing injuries
30 from conventional glass in these applications.

31

32 The mechanism which makes safeglass break, and break into
33 safe parts is the low molecular weight of the material.

34 Low molecular weight in polymers is a function of the

1 length of the chains. In this case the polystyrene resin
2 has a very low molecular weight, too low in fact to be of
3 any use, and also difficult to mould. By mixing low
4 molecular weight polystyrene resin in the molecular mass
5 range 500-5000 to crystal or high impact polystyrene it
6 has the effect of lowering the stress limit of the
7 latter. The resulting material is suitable for the
8 present invention and processing it is greatly improved.
9 The same theory applies to any other clear plastic, such
10 as PMMA (acrylic) for example. By mixing low molecular
11 weight acrylic to high molecular weight acrylic a new
12 material could be produced. In this case we would be
13 looking to produce a material with a molecular weight of
14 approximately 3000 for it to be of any use.

15

16 Two important applications:

17

18 1. GLASSWARE AND BOTTLES: 12000 drink related incidents
19 happen every week. The Home Office are to order
20 magistrates to tighten conditions of pub and club
21 licences to use toughened glasses to serve beer. This
22 will reduce the injuries caused when glasses are used
23 as weapons, currently running at 5500 per year.
24 Safeglass glasses and bottles could play an important
25 safety and security role in clubs or live events, they
26 would also be cheaper than glass.

27

28 2. WINDOWS: Windows set in interior doors have to be made
29 of toughened glass if they are fitted below a certain
30 height, this is to save small children or fall victims
31 from injury. However it is very expensive and still
32 produces tiny cubes of sharp glass. Safeglass is safer
33 and less expensive.

34

1 The safety glass of the present invention will now be
2 described with reference to the following examples.

3

4 **Example 1**

5

6 The safety glass of the preferred embodiment of the
7 invention is composed of crystal or impact polystyrene
8 and an intermediate weight polystyrene resin (of
9 molecular mass 500 to 5000). This material can be
10 manufactured with a stress limit of between 11 to 60 Nmm⁻².
11

12

13 The following table shows the variation of the stress
14 limit value of the preferred embodiment of the safety
15 glass of the present invention.

16

17 **Table 1**

18

SAFEGlass NO.	% CRYSTAL/IMPACT POLYSTYRENE	% POLYSTYRENE RESIN	STRESS LIMIT
1	0	100	11
2	5	95	12
3	10	90	13
4	15	85	14
5	20	80	15
6	25	75	16
7	30	70	16.4
8	35	65	17
9	40	60	18.4
10	45	55	19
11	50	50	19.5
12	55	45	21
13	60	40	27
14	75	25	39
15	80	20	50
16	85	15	60

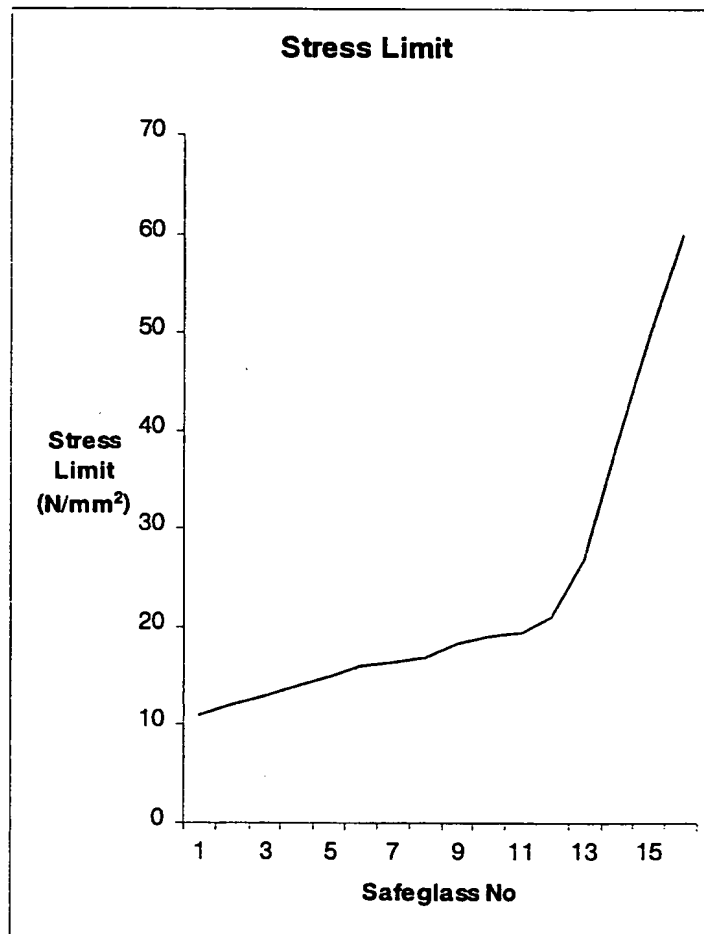
19

20

1 This information is also represented graphically in
2 Figure 1.

3

4 Figure 1



5

6

7 To determine which safety glass composition is to be used
8 in a particular application a stress calculation must be
9 carried out using the following formula.

1 **Formula 1**

2

$$3 \qquad S = \frac{3 F L}{2 b h^2}$$

5

6 where S is the stress limit in N/mm²

7 F is the force in Newtons

8 L is the length of the panel in metres

9 b is the width of the panel in metres

10 h is the depth of the panel in metres

11

12 **Example 2**

13

14 As Example 1 with the inclusion of the thermoplastic
15 resin obtained by polymerisation of various vinylaromatic
16 monomers.

17

18 **Example 3**

19

20 As Example 2 except that the crystal/impact polystyrene
21 is replaced by polycarbonate.

22

23 **Example 4**

24

25 As Example 2 except that the crystal/impact polystyrene
26 is replaced by acrylonitrile.

27

28 **Example 5**

29

30 As Example 2 except that the crystal/impact polystyrene
31 is replaced by ABS (acrylonitrile butadiene styrene).

32

1 **Example 6**

2

3 As Example 2 except that the crystal/impact polystyrene
4 is replaced by SAN (styrene and acrylic blend).

5

6 **Example 7**

7

8 As Example 2 except that the crystal/impact polystyrene
9 is replaced by polyester.

10

11 Further modifications and improvements may be added
12 without departing from the scope of the invention herein
13 intended.

1 **Claims:**

2

3 1. A material having a tensile stress limit of between 11
4 and 60 Nmm⁻², that is or can be made transparent and
5 can be made into sheets/structures just like ordinary
6 glass, but that shatters when broken into fragments
7 that are not capable of damaging human skin or tissue
8 and which is comprised of a mixture of polymeric
9 material and/or a thermoplastic polystyrene resin
10 and/or a thermoplastic vinylaromatic resin.

11

12 2. A material as claimed in Claim 1 wherein the polymeric
13 material is chosen from the group consisting of crystal
14 or impact polystyrene, polycarbonate, acrylic, ABS
15 (acrylonitrile butadiene styrene), SAN (styrene and
16 acrylic blend) and polyester.

17

18 3. A material as claimed in Claim 1 or 2 wherein the
19 thermoplastic polystyrene resin is chosen from the
20 group consisting of co-polymers of styrene and alpha
21 methyl styrene, hydrogenated aliphatic polymer and
22 styrene monomer.

23

24 4. A material as claimed in Claim 3 the thermoplastic
25 polystyrene resin has a molecular mass of between 500
26 and 5000.

27

28 5. A material as claimed in any one of the preceding
29 Claims wherein said material further includes
30 ingredients selected from the list of UV inhibitors,
31 antioxidants, flow modifiers, fire retarding agents,
32 colour pigments and brighteners.

33

- 1 6. A material as claimed in Claim 5 wherein the
- 2 ingredients are present at between 0.001% and 0.01%.
- 3
- 4 7. A material as claimed in any one of the preceding
- 5 Claims wherein said material may be etched upon.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/00946

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C08L25/06 C08L69/00 C08L33/12 C08L55/02 C08L25/12
C08L67/02 C08L67/00

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C08L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ABETZ V ET AL: "THE GLASS TRANSITION OF MIXTURES OF POLYSTYRENE WITH ALKYL-TERMINATED OLIGOSTYRENE - EXPERIMENTAL EVIDENCE FOR MICROPHASE SEPARATION IN A POLYMER BLENDS" MACROMOLECULAR CHEMISTRY AND PHYSICS, vol. 196, no. 11, 1 November 1995 (1995-11-01), pages 3845-3857, XP000583913 ISSN: 1022-1352 page 3847, Tab. 1, "Blend preparation" ---	1-4, 7
X	WO 97 15868 A (MINNESOTA MINING & MFG) 1 May 1997 (1997-05-01) page 7, line 12-24 page 18, line 10-24 --- -/--	1, 2

☒ Further documents are listed in the continuation of box C.

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- 10 August 1999

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94 29383 A (DOW CHEMICAL CO) 22 December 1994 (1994-12-22) claims 1,4; tables 3,5 ---	1-7
A	DE 22 39 356 A (BASF AG) 21 February 1974 (1974-02-21) page 2, line 3-33 -----	1-7

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int: lonal Application No

PCT/GB 99/00946

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9715868 A	01-05-1997	AU 706152 B AU 5577596 A CN 1200182 A EP 0857321 A	10-06-1999 15-05-1997 25-11-1998 12-08-1998
WO 9429383 A	22-12-1994	US 5422378 A AT 177132 T CA 2161887 A DE 69416833 D DE 69416833 T EP 0701589 A ES 2127929 T FI 955792 A HU 75497 A JP 8511055 T NO 954900 A	06-06-1995 15-03-1999 22-12-1994 08-04-1999 01-07-1999 20-03-1996 01-05-1999 01-12-1995 28-05-1997 19-11-1996 01-02-1996
DE 2239356 A	21-02-1974	BE 803358 A FR 2195642 A JP 49075660 A NL 7310843 A	08-02-1974 08-03-1974 22-07-1974 12-02-1974